## Executive Summary

In June 2000, the Washington State Department of Ecology issued Administrative Orders 00NWPKW-1250 and 00NWPKW-1251 providing prescriptive examination requirements for all double-shell tanks by FY 2005. In 2003, the Administrative Orders were incorporated into the Hanford Federal Facility Agreement and Consent Order (HFFACO), Milestones Series M-48. Milestone M-48-14 requires an integrity assessment report be written and certified by the Independent Qualified Registered Professional Engineer (IQRPE).

Based on the Independent Qualified Registered Professional Engineer (IQRPE) Assessment of the Dome Load Program for Double Shell Tanks, RPP-20556, Revision 0, a dome deflection monitoring program must be put in place to monitor deflection of the tank domes.

The Hanford Site Tank Farm Technical Safety Requirements (TSR) requires dome load controls. The procedural requirement for the dome load controls is TFC-ENG-FACSUP-C-10, "Control of Dome Loading" with the basis for the dome load limits from RPP-20473 "Design and Dome Load Criteria for Hanford Waste Storage Tanks". The monitoring of the tank domes by survey is required to physically verify the structural integrity of the tanks as deflection is key indicator of structural integrity. A Problem Evaluation Report (PER) PER-2004-6294 identifies the lack of a documented design basis and protocol program to conduct dome surveys.

This RPP-25782 establishes the basis and protocol for the DST Dome Survey Program. The goal of this program is to monitor the elevation of the tank and tank dome deflection to determine if settlement or if excess deflection of the tank dome is occurring. The surveys should be performed as requested by engineering or in accordance with this document.

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## List of Terms

### Abbreviations and Acronyms

| | |
|---|---|
| DST | Double Shell Tank |
| HFFACO | Hanford Federal Facility Agreement and Consent Order |
| IQRPE | Independent Qualified Registered Engineer |
| MOP | Management Observation Program |
| PER | Problem Evaluation Report |
| PLS | Professional Land Surveyor |

## 1.0 Introduction

In June 2000, the Washington State Department of Ecology issued Administrative Orders 00NWPKW-1250 and 00NWPKW-1251 providing prescriptive examination requirements for all double-shell tanks by FY 2005. In 2003, the Administrative Orders were incorporated into the Hanford Federal Facility Agreement and Consent Order (HFFACO), Milestones Series M-48. Milestone M-48-14 requires an integrity assessment report be written and certified by the Independent Qualified Registered Engineer (IQRPE).

Based on the integrity assessment report (RPP-20556, *IQRPE Assessment of the Dome Load Program for Double Shell Tanks*), the behavior of the Double Shell Tank (DST) domes need to be quantified. This will be part of the Double-Shell Tank Integrity program that assesses the structural and leak integrity of the DST's. The "analysis of record" for the DST tanks is RPP-11801.

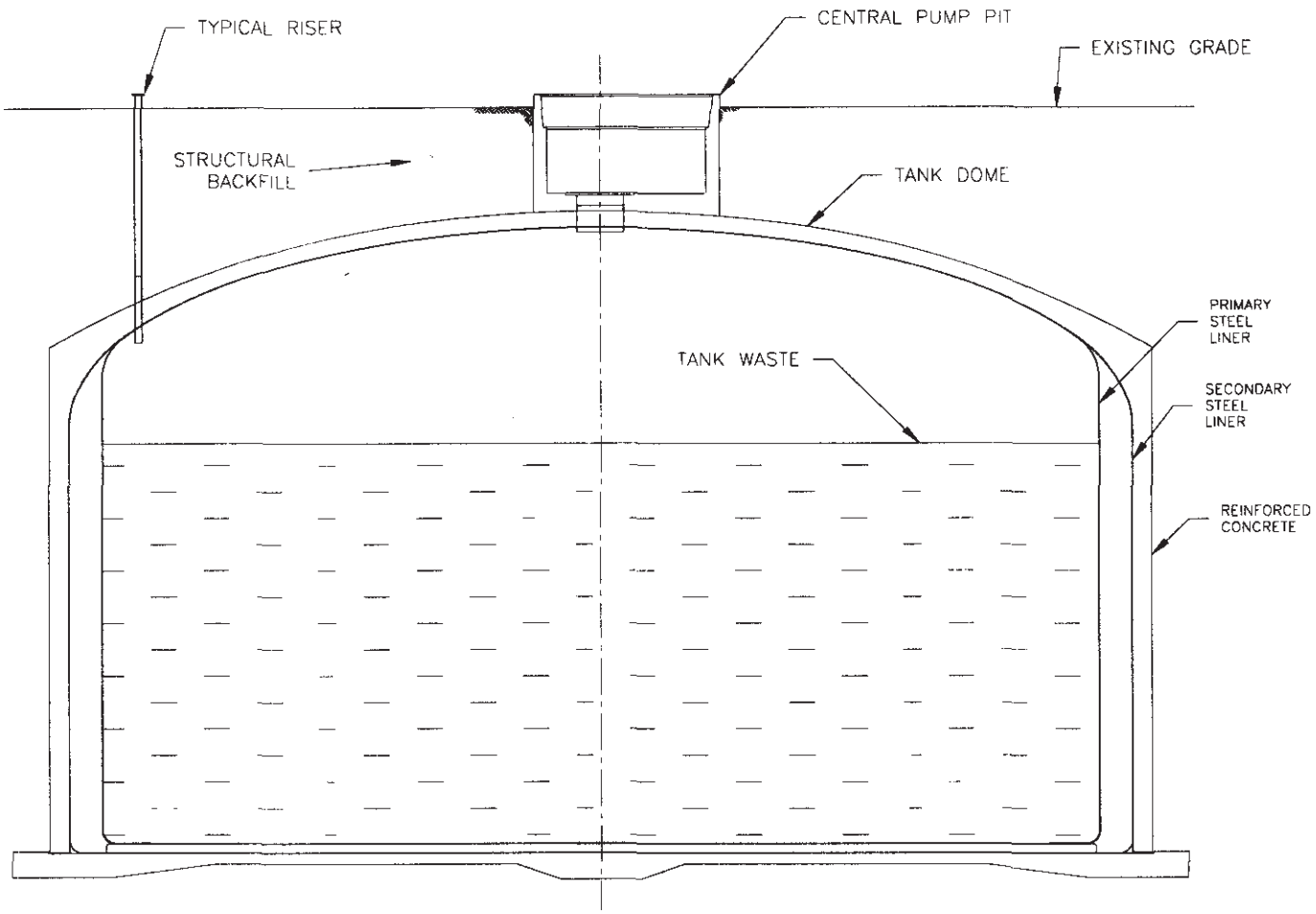
The Hanford Site Tank Farm Technical Safety Requirements (TSR) requires dome load controls. The procedural requirement for the dome load controls is TFC-ENG-FACSUP-C-10, "Control of Dome Loading" with the basis for the dome load limits from RPP-20473 "Design and Dome Load Criteria for Hanford Waste Storage Tanks". The monitoring of the tank domes by survey is required to physically verify the structural integrity of the tanks as deflection is key indicator of structural integrity. A Problem Evaluation Report (PER) PER-2004-6294 identifies the lack of a documented design basis and protocol program to conduct dome surveys.

This document establishes the basis and protocol for the DST Dome Survey Program. The goal of this program is to monitor the elevation of the tank and tank dome deflection to determine if settlement of the tank is occurring or if excess deflection of the tank dome is occurring. The surveys should be performed as requested by engineering or in accordance with this document.

## 2.0 Background

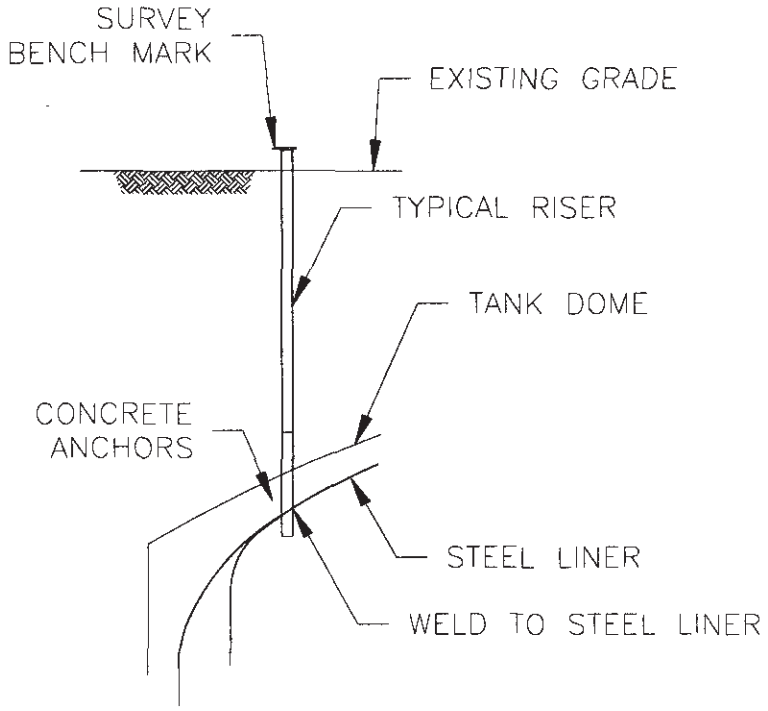
Six double shell tank farms are located on the Hanford site. Between two and eight tanks are located in each of these farms. Each DST has a primary steel liner, a secondary steel liner and reinforced concrete surrounding the steel liner. The top portion of the reinforced concrete is called the tank dome. The DST dome is 15 inches of reinforced concrete with a 3/8" thick steel liner attached to it. See *Figure 1* for a cross section of a typical DST.

**Figure 1. DST Cross Section**




As shown in *Figure 1*, the tank dome is buried to a depth of six to eight feet as measured from the tank dome apex. This soil cover prevents direct measurement of the tank. Numerous steel pipe risers are attached to the tank dome and extend through the soil to the surface. Survey benchmarks attached to these risers are used to measure tank elevation changes. As shown in *Figure 2*, the bottoms of the risers are welded to the steel liner and concrete anchors connect the steel pipe to the concrete. Any tank settlement or deflection of the tank dome will cause a change in elevation of the tank benchmarks which are directly attached to the tank dome. One additional benchmark is attached to the top of each of the central pump pits. The central pump pits on all DST tank farms were built directly on the tank dome as shown in *Figure 1*. Like the riser benchmarks, a change in tank dome elevation will directly change the elevation of a benchmark located on the pit.

**Figure 2. Riser/Dome Interface**




The DST's were constructed from the late 1960's through the early 1980's when the AP-Tank Farm was placed in service. During this time, horizontal and vertical survey control monuments were installed to control and record the location and elevations of the tanks and components. The location of bench marks is shown in *appendix C* and control monuments are shown in *Appendix D* (RPP-25782, *DST Dome Survey Program*). Over the years, some of these original control monuments have been destroyed.

From 1979 through 1989, SY, AN, AW, AY and AZ tank farms were surveyed. In 1990, the surveys were discontinued for unknown reasons. Surveys were started again in 2005. An evaluation of these historical survey records is provided in *Appendix E* (RPP-25782). A copy of the 1986 survey protocol is provided in *Appendix F* (RPP-25782). There is no apparent excessive deflection and no deflection greater than .02 ft. (.24 inch), however some data does appear to show dome deflection upward.

Part of the DST Dome Survey Program has included installing additional new control monuments and new benchmarks where needed. The standard for each tank farm includes the following:

- A minimum of two control monuments in the area of each tank farm

- Four riser benchmarks located on annulus risers on each quadrant of the tank to monitor tank settlement except AP Farm where three benchmarks are provided. Providing three benchmarks in AP Farm is acceptable to the IQRPE as shown in *Appendix F* (RPP-25782).

- A minimum of two riser benchmarks and one pit benchmark located over the tank dome to monitor dome deflection

The DST dome survey program applies to the following 28 DST's located in six tank farms:

SY TANK FARM

- 241-SY-101, 241-SY-102, 241-SY-103

AN TANK FARM

- 241-AN-101, 241-AN-102, 241-AN-103, 241-AN-104, 241-AN-105, 241-AN-106, 241-AN-107

AP TANK FARM

- 241-AP-101, 241-AP-102, 241-AP-103, 241-AP-104, 241-AP-105, 241-AP-106, 241-AP-107, 241-AP-108

AW TANK FARM

- 241-AW-101, 241-AW-102, 241-AW-103, 241-AW-104, 241-AW-105, 241-AW-106

AY TANK FARM

- 241-AY-101, 241-AY-102

AZ TANK FARM

- 241-AZ-101, 241-AZ-102

## 3.0 Dome Deflection Survey Program

All control survey work for locating control monuments and performing dome elevation surveys will be performed using best survey industry practices. The Washington Administrative Code WAC 332-130 and the Revised Code of Washington RCW Title 58 shall be used as guidance. However, since this is not establishing boundaries or land office corners, no specific Washington state laws or DOE regulations govern the performance of tank dome elevation surveys.

Closure on all survey level loops shall not exceed 0.02 feet with a level of accuracy of three

significant figures. Each survey should be performed in a similar fashion to each tank's previous survey in order to maintain consistency.

All surveying activities will be supervised by a Professional Land Surveyor (PLS) licensed in the State of Washington. The PLS shall abide by the Revised Code of Washington (RCW), Chapter 18.43, *ENGINEERS AND LAND SURVEYORS* and the Washington Administrative Code (WAC), Chapter 196-27A, *RULES OF PROFESSIONAL CONDUCT AND PRACTICE.*

## 3.1 General

In general, the survey activity will include the following:

Pre-Survey Planning

1 Propose a schedule to perform the necessary survey of each of the tank farms within the required periods. Obtain CH2M HILL approval of the schedule.

2 Determine the tank(s) to be surveyed and obtain the Tank Survey Record for each tank. The tank survey record will include the relevant tank, control benchmark, and monument information.

3 Verify that the survey instrument accuracy is within the required tolerances. The survey instrument used must have a horizontal sensitivity of 3.0 second of arc, or better and the elevation staff shall have a least count scale equivalent to 0.01 feet or less.

Field Work

4 Within 48 hours of a scheduled survey, the subcontractor shall contact the Buyer's Technical Representative for the purposes of confirming the survey site availability and ensuring that current environmental conditions will be acceptable for performing the services.

5 Visual check of the control monuments for signs of visible damage or other signs indicating questionable integrity.

6 Performance of the primary level loop survey for each tank: (from a primary control monument, turn through one bench mark on each tank closing on a control monument).

7 Performance of the secondary level loop survey for each tank: (begin at a bench mark on the tank which was part of the primary level loop, and then turn through all available bench marks on that tank closing on another bench mark which was part of the primary level loop).

8 If deflections are in excess of 0.02 feet perform notifications per *Section 3.3*. Post Survey

Tank Survey Record & Field Survey Notes

9 Update the Tank Survey Record for each tank.

10 Within 2 weeks following the completion of the survey, send the completed field survey notes and updated Tank Survey Record to the Buyer's Technical Representative. The field survey notes to include the tank numbers surveyed the date of the survey, crew names, the environmental conditions including approximate temperature and wind speed and identification of the survey equipment used (including calibration date if applicable).

## 3.2 Survey Equipment

The following requirements are necessary to ensure that the required survey tolerances are met:

- The survey instrument used shall have a horizontal angular accuracy of 3.0 second of arc, or better.
- The survey instrument shall have a compensator setting accuracy of +/- 0.3 second.
- The elevation staff shall have a least count scale equivalent to 0.01 feet or less.
- All surveys shall be performed in accordance with the survey equipment manufacturer's recommendations to maintain the required accuracy.

Currently, some in-farm work requires the use of fresh air respirators. The use of this type of Personal Protective Equipment PPE limits the surveyor's ability to visually take level readings. Alternates to optical equipment should be considered such as a digital level or laser scanning.

## 3.3 Survey Tolerance and Errors

A decrease in benchmark elevation between surveys indicates that a dome deflection may have occurred or other survey errors have occurred. It is expected that the surveys should be repeatable to ±0.01 feet (±0.12 inch). If a deflection has changed more than ±0.02 feet since the last survey, the survey must be repeated to verify the accuracy of the results. Items to check if the tolerance of ±0.02 feet is exceeded are as follows:

- Calibration of survey equipment.
- Appropriate survey procedures have been followed.
- Determination if control monuments have been disturbed or there are other signs indicating questionable integrity.

- Tank benchmarks have been damaged.

If a dome deflection has changed by more than 0.02 feet and rechecking of the survey and survey data has been performed, then immediately notify the Civil/Structural Discipline Lead Engineer and Waste Feed Engineering so the condition can be documented in the Problem Evaluation and Reporting (PER) system.

## 3.4 Survey Control Monuments and Benchmarks

Although the tank farm control monuments are not required to meet geodetic control requirements, they all are to be referenced back to the geodetic control for the site.

- As dome surveys are performed, the conditions of the benchmarks are reviewed. If a control monument or benchmark is damaged or of questionable integrity, notify the Civil/Structural Discipline Lead Engineer and Waste Feed Engineering so the condition can be documented in the PER system.

- If applicable, establish the location and elevation of all new monuments or benchmarks. New benchmarks or monuments shall be evaluated to validate consistency with the historic survey data.

- See drawing H-2-68529 for standard bench mark and monument designs.

## 3.5 Frequency

Tank Dome Surveys are to be performed on a 2 years ±4 months frequency. Additional surveys may be required when tank dome loading significantly changes or there is increased work activity in the tank farm. Dome survey frequency shall be determined by the structural Discipline Lead Engineer.

## 3.6 Expected Deflection

Deflection of the tank dome of up to approximately ½ inch is within dome load limits per RPP-RPT-25608 Rev. 0. Significant load is required to achieve this degree of deflection. All survey data should be reviewed by the responsible tank farm engineer and evaluated for tank settlement and for dome deflection. Measurable deflection of approximately ¼ inch could be expected but deflection in excess of ¼ inch should be reviewed by the Civil/Structural Discipline Lead Engineer.

Dome deflection can be determined by subtracting the elevation at the center of the dome from the elevation at the perimeter of the tank. Settlement of the tank can be determined by subtracting the most current elevation at the perimeter of the tank from the first, or oldest, survey elevation at the perimeter of the tank.

## 3.7 Survey Data

The Tank Survey Record will contain the following information for each tank:

**Tank Benchmark Specific information**

The following information shall be recorded on the data sheet for each tank benchmark

| Tank Number | Riser / Pit Number | | |
|---|---|---|---|
| Date | Current Elevation | Δ From Previous Elevation | Total Δ Original Elevation |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

The Survey field notes shall include the following information:

- Tank number
- Survey date
- Crew names
- Weather including approximate temperature and wind speed
- Control Monuments used and shall indicate if signs of damage or other signs indicating questionable integrity were observed.
- Survey equipment used

### 3.8 Survey Data Sheets Disposition

Once the survey data is complete for a tank, the respective *Tank Farm Historic Dome Load Record Data* document needs to be modified to include the new survey data and a copy of the dome load log for that specific tank. See *Table 1* for the listing of documents for each DST farm. DST engineering is responsible for the upkeep of these *Record Data* documents.

**Table 1. DST Dome Load Record Data Documents**

| RPP No. | TITLE DESCRIPTION |
|---|---|
| RPP-20257 | 241-AN Tank Farm Historic Dome Load Record Data |
| RPP-20258 | 241-AP Tank Farm Historic Dome Load Record Data |
| RPP-20259 | 241-AW Tank Farm Historic Dome Load Record Data |
| RPP-20260 | 241-AY Tank Farm Historic Dome Load Record Data |
| RPP-20261 | 241-AZ Tank Farm Historic Dome Load Record Data |
| RPP-20262 | 241-SY Tank Farm Historic Dome Load Record Data |

## 4.0 Deliverables:

If surveying is a subcontracted task it is recommended that a submittal of an updated Tank survey Record and Survey Notes be provided. The hardcopy submittal of these documents is to be stamped by a Professional Land Surveyor (PLS) licensed in the State of Washington. An electronic copy of the documents (not required to be stamped) is also to be provided.

## 5.0 References

Administrative Order No.00NWPKW-1250 and 1251, *Failure to Comply with Major Milestone M-32 of the Tri-Party Agreement*, Washington State Department of Ecology, Olympia, Washington.

ECN-721313, *Dome Survey Pit Benchmarks for AY, AZ, AN, AW, SY Tanks*, Rev. 0, COGEMA Engineering, Richland, Washington.

ECN-721241, *Dome Survey Benchmarks for AP, AY, AZ Tanks*; Rev 0, COGEMA Engineering, Richland, Washington.

ECN-741264, *Dome Survey Benchmarks for AN, AW, and SY Tanks*, Rev 0, COGEMA Engineering, Richland, Washington.

Hanford Federal Facility Agreement and Consent Order (HFFACO), 2003, by the Washington State Department of Ecology, the United States Environmental Protection Agency, and the United States Department of Energy, 89-10 REV. 6, as amended through April 24, 2003.

HNF-SD-WM-TSR-006, *Tank Farm Technical Safety Requirements*, CH2M Hill Hanford Group, Inc., Richland, Washington.

PER-2004-6294, *MOP was performed for the DST Dome Survey program*, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-11801, *DST Analysis of Record*, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-20473, *Design and Dome Load Criteria for Hanford Waste Storage Tanks*, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-20556, *IQRPE Assessment of the Dome Load Program for Double Shell Tanks*, Rev. 0, Los Alamos Technical Associates, Inc., Richland, Washington.

RPP-25782, *DST Dome Survey Program*, Rev. 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

RPP-RPT-25608, *Increased Concentrated Loads Report*, Rev. 0, CH2M Hill Hanford Group, Inc., Richland, Washington.

TFC-ENG-FACSUP-C-10, *Control of Dome Loading*, CH2M Hill Hanford Group, Inc., Richland, Washington.